



## Original research

## Y-balance normative data for female collegiate volleyball players

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## ABSTRACT

**Objective:** The Lower Quarter Y Balance (YBT-LQ) Test performance varies depending on competitive level, sport, gender, and age; therefore, determining normative scores specific to a population may be helpful in identifying injury-risk thresholds and return-to-play criteria following an injury. The purpose of this study was to determine normative YBT-LQ scores by assessing a subset of female, Division I volleyball players.

**Design:** A descriptive analysis cohort study.

**Participants:** Ninety healthy ( $19.6 \pm 1.2$  y/o), collegiate female volleyball players.

**Main outcome measures:** YBT-LQ was measured in 3 distinct directions of anterior (ANT), posteromedial (PM) and posterolateral (PL) on both the dominant and non-dominant limbs. In addition, a one way ANOVA was performed to determine mean group differences of YBT-LQ dominant and non-dominant limb composite score across position.

**Results:** Baseline values for this population were  $94.1 \pm 6.6\%$  on the dominant limb and  $93.9 \pm 6.2\%$  on the non-dominant limb. There were no significant differences for YBT-LQ composite scores on dominant ( $P = 0.867$ ) and non-dominant ( $P = 0.989$ ) limbs between position.

**Conclusions:** This study identified normative YBT-LQ composite scores for healthy, female, collegiate volleyball players. Participants performed similarly despite their position.

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## 1. Introduction

Female volleyball players are at risk for injury each time they step on the court, with an injury incidence of  $1.7 \pm 0.3$  injuries per 1000 player hours (Aagaard & Jorgensen, 1996; Agel, Palmieri-Smith, Dick, Wojtys, & Marshall, 2007; Bahr & Bahr, 1997). The National Collegiate Athletic Association (NCAA) injury surveillance data, spanning 16 years, has shown that more than 55% of female collegiate volleyball injuries involve the lower extremity (Agel et al., 2007). These injuries can lead to a significant loss of playing time for the athlete (Aagaard & Jorgensen, 1996). The ankle is the most common site of injury in collegiate volleyball players during games and practices, with injury rates as high as 44.1% and 29.4%, respectively (Agel et al., 2007). While the ankle is the most common joint to be injured, knee injuries are second in prevalence among volleyball players accounting for 14.1% of game injuries and 7.8% of practice injuries (Agel et al., 2007). Knee injuries result in the greatest game or training time missed due to injury (Aagaard &

Jorgensen, 1996). On average, an athlete with a knee injury is out for 34 days and may experience prolonged symptoms, averaging 88 days (Aagaard & Jorgensen, 1996). In contrast ankle injuries result in an average of 8 days missed and 41 days of symptoms (Aagaard & Jorgensen, 1996). A number of risk factors contribute to these injuries, including but not limited to any previous injuries, sex, biomechanical and anatomical factors, decreased muscle flexibility, and poor balance (Garrison, Bothwell, Cohen, & Conway, 2014; Hewett et al., 2005; Hrysomallis, 2007; Huston, Greenfield, & Wojtys, 2000; Joseph et al., 2011; Knapik, Bauman, Jones, Harris, & Vaughan, 1991; Plisky, Rauh, Kaminski, & Underwood, 2006; Verhagen, Van der Beek, Bouter, Bahr, & Van Mechelen, 2004; Witvrouw, Bellemans, Lysens, Danneels, & Cambier, 2001).

Clinicians often use an injury-screening tool associated with dynamic lower extremity (DLE) balance to evaluate risk of injury and return to sport criterion following an injury. Dynamic lower extremity balance is the ability to maintain stability of an individual's center of mass during movement (Butler, Southers, Gorman, Kiesel, & Plisky, 2012). Poor DLE balance performance has been previously associated with an increased risk for injury in a variety of populations (Bouillon & Baker, 2011; Bressel, Yonker, Kras, & Heath, 2007; Butler et al., 2012; Butler, Lehr, Fink, Kiesel,

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& Plisky, 2013; Butler, Queen, Beckman, Kiesel, & Plisky, 2013; Garrison et al., 2014; Gorman, Butler, Rauh, Kiesel, & Plisky, 2012; Herrington, Hatcher, Hatcher, & McNicholas, 2009; Olmsted, Carcia, Hertel, & Shultz, 2002; Plisky et al., 2006). The Star Excursion Balance Test (SEBT), a test of DLE balance, has previously been used to predict lower extremity injury in female high school basketball players (Plisky et al., 2006). An anterior reach difference of 4 centimeters (cm) or more or a composite score (normalized to leg length) less than or equal to 94% for female basketball players on the SEBT has been used as a predictor for increased risk of lower extremity injury (Plisky et al., 2006).

The Lower Quarter Y Balance Test (YBT-LQ) is a simplified and reliable derivative of the SEBT (Gribble, Hertel, & Plisky, 2012; Hyong & Kim, 2014; Plisky et al., 2006; Plisky, Gorman, Butler, Kiesel, Underwood, & Elkins, 2009), which is a measure of single leg balance and dynamic neuromuscular control, strength, flexibility, and proprioception (Clanton, Matheny, Jarvis, & Jeronimus, 2012; Lehr, Plisky, Butler, Fink, Kiesel, & Underwood, 2013). For effective clinical use, a dynamic balance test needs to capture the greatest amount of information in the shortest amount of time thus the YBT-LQ variation is an efficient tool to detect risk of lower extremity injury (Plisky et al., 2009; Smith, Chimera, & Warren, 2015). Using the YBT-LQ, it has been determined a college football player with a composite score of less than 89.6% is 3.5 times more likely to sustain a non-contact lower extremity injury (Butler, Lehr, et al., 2013). In addition, high school female athletes with YBT-LQ composite scores below 94% were 6.5 times more likely to experience a lower extremity injury (Plisky et al., 2006). YBT-LQ composite scores vary across sports and level of competition (Bressel et al., 2007; Butler et al., 2012; Butler, Lehr, et al., 2013; Garrison, Arnold, Macko, & Conway, 2013; Plisky et al., 2006). Differences in reach distances between high school (HS), college (COL), and professional (PRO) soccer players revealed the HS group had a greater anterior reach distance than the other 2 groups ( $P = 0.03$ ). In contrast, the HS group had less reach distance in the posteromedial and posterolateral directions than the other groups ( $P < 0.01$  for both). HS players ( $98.4 \pm 1.1$ ) tended to exhibit a lower composite reach score than COL ( $100.94 \pm 0.9$ ) and PRO ( $101.8 \pm 1.2$ ), but this difference was not significant ( $P = 0.08$ ) (Butler et al., 2012). Previous research suggests that soccer players score higher on dynamic balance compared to basketball players when measured by normalized leg reach distances on the SEBT ( $P = 0.04$ ) (Bressel et al., 2007). The literature also indicates that

gymnasts and dancers have superior balance compared to soccer players as assessed through center of pressure (COP) sway index (Germino, Griffin, & Zurakowski, 2007; Matsuda, Demura, & Uchiyama, 2008).

Performance on the YBT-LQ test varies depending on competitive level (Butler et al., 2012), sport (Bressel et al., 2007; Butler, Lehr, et al., 2013; Garrison et al., 2013; Plisky et al., 2006), gender (Gorman et al., 2012), and age (Bouillon & Baker, 2011); therefore, determining normative scores specific to a population may be helpful in identifying injury-risk thresholds and return-to-play criteria following an injury. While there are known YBT-LQ values for soccer, baseball, basketball, and football athletes, there is presently no research available on volleyball players' performance on YBT-LQ; therefore, the aim of the current study is to determine these normative YBT-LQ scores by assessing a subset of female, Division I volleyball players.

## 2. Methods

### 2.1. Participants

Ninety female collegiate volleyball players volunteered to participate in this study from 8 different Division I universities. All subjects gave informed consent to participate and the rights of each person were protected. The Institutional Review Board of Texas Health Resources approved the research procedures. Subjects were considered for study participation if they were a female athlete between the ages of 18 and 25 years old and playing collegiate volleyball. Injured athletes that were unable to play or practice at the time of data collection were excluded from the study. Patients were enrolled into the study by an investigator at the facility once screened for the inclusion and exclusion criteria. Once the patient offered consent, objective measurements of YBT-LQ were taken.

### 2.2. Testing

The YBT-LQ was utilized as a measure of trunk and lower extremity function (Garrison et al., 2013). The YBT-LQ assesses range of motion (ROM), strength, and neuromuscular control of the lower extremity and was chosen to assess the participants' lower limb balance as numerous prior studies have demonstrated its utility as a clinical test to assess for lower limb balance deficits in the athletic population (Paterno, Myer, Ford, & Hewett, 2004; Plisky et al., 2006,

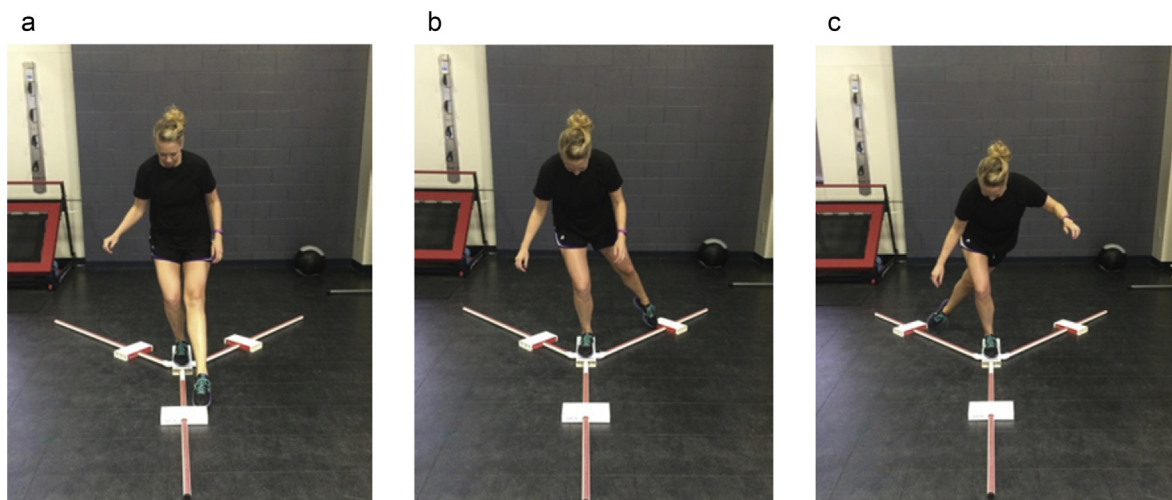


Fig. 1. a. Y-balance anterior reach, b. Y-balance posteromedial reach, c. Y-balance posterolateral reach.

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